White River Waterkeeper

Comment submission 2 of 2.
Attachments 1-5 associated with WRW's comments submitted in submission 1 of 2.

https://www.arkansasonline.com/news/2020/jan/07/payment-made-state-gains-hog-farm-land-/#

Payment made, state gains hog farm land; Buffalo River's protection still seen as priority

*by **Emily Walkenhorst** | January 7, 2020 at 6:44 a.m.*

3

Follow

FILE — The C&H Hog Farms complex, shown in 2017, was located on Big Creek 6.6 miles from where the creek flows into the Buffalo River. (Mitchell PE Masilun)

Arkansas has paid the owners of C&H Hog Farms $6.2 million for their former farmland in the Buffalo River watershed, and the state now possesses the land in the form of a conservation easement.

Completion of the agreement between the state and the farm's owners was announced Monday in a news release from the Arkansas Department of Parks, Heritage and Tourism.

No plans have been announced for the land, but its transfer to the state as a conservation easement -- which limits its potential uses -- is the beginning of a new chapter for the river's watershed.

The watershed received renewed attention and protection efforts as a result of the farm's opening in 2013. But the farm's nearly completed closure -- the state is responsible for the closure of two manure holding ponds on the property -- won't spell the end of efforts to help protect the country's first "national" river.

"I appreciate the willingness of the farmers to work with us on this, and now look forward to the work that the state will be doing to ensure that the Buffalo National River continues to be the treasure that it is," Gov. Asa Hutchinson said in the news release from the Department of Parks, Heritage and Tourism, which will manage the easement.

"It's been a long road to get to this point but has been worth the effort as a step to ensure the vitality of the Buffalo National River now and into the future," department Secretary Stacy Hurst said in the release.

The conservation easement signals the near end of the farm, but the debate over whether it was hurting the environment is still unsettled.

"I'm glad that we've reached this milestone, and hopefully we can get the closure plan finalized in a not-too-long period of time and we can put this thing to bed," said Gordon Watkins, president of the Buffalo River Watershed Alliance.

The farm's land sits on Big Creek, about 6.6 miles from where it flows into the Buffalo River. For the past several years, people from Arkansas and from across the nation have expressed concern about the possibility of manure -- applied as fertilizer -- running off the property and into the water, or about the possibility of a major storm event overfilling the ponds that hold thousands of gallons of hog manure.

Research paid for by the state, conducted by the University of Arkansas System Division of Agriculture, has not concluded that C&H negatively affected water quality in Big Creek or the Buffalo River.

In recent years, the Buffalo River has struggled with algal blooms along tens of miles of its middle section and high E. coli levels near the Big Creek intersection.

Because algae-causing nutrients can build up and embed in soil years before leaching into water, groups like the Buffalo River Watershed Alliance have asked that the state or federal government continue robust monitoring on Big Creek and the Buffalo River. The state has monitors on both, but the study sampled from more locations on a more frequent basis.

C&H, permitted with little public notice in 2012, was allowed to house up to 6,503 hogs, although it normally operated with about 3,000.

In June, Hutchinson announced the state would buy out the farm after more than six years of operation. The farm was by far the largest in the watershed and one of the largest in the state.

The buyout agreement stipulated the payment, the easement and the dismissal of each lawsuit C&H had brought against the state. The lawsuits were mostly related to recent denials of C&H's operating permit applications, although one concerned an alleged violation of the Arkansas Freedom of Information Act by state environmental regulators after records sought by the farmers were not procured within three days of the farmers' request.

That announcement was followed by the Arkansas Pollution Control and Ecology Commission's decision to permanently ban any federally classified medium or large hog farms in the watershed. That decision is pending public comments and eventually legislative review, and some commenters have contended that the ban has potential loopholes that would allow a facility similar to C&H to open there.

Arkansas paid $6.2 million, using state and donated money, to the farmers after the final hogs were removed from the premises. About $3.7 million came from the governor's rainy-day fund; another $1.5 million came from the Department of Parks, Heritage and Tourism; and the final $1 million came from The Nature Conservancy. About $2.4 million of that was used to pay off the farm's remaining debt.

C&H began removing hogs from its property last fall. They were reportedly gone before Christmas, Watkins said.

Operations have ceased at the premises, and all that is left to do to close the facility is emptying the manure ponds. The Arkansas Division of Environmental Quality will be responsible for that part but is reviewing public comments on its proposed method.

Work to improve the Buffalo River's present and future remains.

"We're not going away," Watkins said.

The Buffalo River Watershed Alliance formed in 2013 specifically to oppose the farm's presence within the watershed and so close to the river and a major tributary of it.

Even without considering C&H's potential effect, the river suffers from too many nutrients loading into the water from long-ago agricultural practices and current wastewater treatment plant failures, Watkins said.

He said he wants to promote best practices in agriculture that would reduce the amount of phosphorus or nitrogen applied to land, which can leach into water. Those elements are nutrients, which in higher amounts can result in oxygen deficiencies and algae growth.

Wastewater plants in Jasper, Marble Falls and Marshall need help and funding to properly function, Watkins said. In those areas, not enough people are in the wastewater systems to pay to maintain them, he said.

Watkins said he would like to see those towns get the assistance they need, possibly with the state's Buffalo River Conservation Committee helping to leverage federal funds.

A Section on 01/07/2020

Print Headline: Payment made, state gains hog farm land; Buffalo River’s protection still seen as priority

https://www.arkansasonline.com/news/2019/oct/14/hog-farm-proposal-garners-support-20191/

Hog farm proposal garners support

But commenters note ban's limits*by* ***Emily Walkenhorst*** | *October 14, 2019 at 2:43 a.m.* | *Updated October 14, 2019 at 2:43 a.m.*

1

FILE — The C&H Hog Farms complex, shown in 2017, was located on Big Creek 6.6 miles from where the creek flows into the Buffalo River. (Mitchell PE Masilun)

Hundreds of comments have poured in supporting a proposed permanent ban on federally classified medium or large hog farms in the Buffalo National River's watershed.

But a handful of comments expressed concerns that, during the process of state regulators editing existing rules to incorporate the ban, significant changes were made to aspects of state rules that had nothing to do with hog farms.

People had several weeks to submit comments on the proposed ban, with the comment period ending Sept. 23. By law, the Arkansas Department of Energy and Environment, which proposed the ban, must read and respond to each comment before altering and/or passing along the proposal for legislative review.

Just more than 400 people submitted comments, with nearly all in favor of a ban.

The *Arkansas Democrat-Gazette* reviewed the comments after obtaining them through a public-records request. Unlike in previous rule-making proposals, the department has not posted the comments online.

Many comments hit on the same themes: calling the C&H Hog Farms permit a mistake, arguing that the karst topography of the region is unsuitable for sizable hog farms, and/or supporting broader restrictions in the watershed. The suggested restrictions include prohibiting small hog farms, barring other types of concentrated animal-feeding operations, and preventing the transport of hog manure and spread of hog manure on land within the Buffalo River's watershed.

Most comments came from Arkansas, largely from the Northwest.

Only two comments opposed any ban. The Arkansas Farm Bureau contended that state regulators have "no scientific evidence showing animal agriculture is causing an environmental impact." The Farm Bureau said the department was letting "emotion" rather than "sound science" drive the regulation changes.

The Arkansas Pork Producers Association said the proposed regulation changes were a "slippery slope" to further action in the state's other watersheds for "extraordinary resource" waters. The proposal is precautionary, the comment states, adding that "Our state's pork producers have an excellent environmental record."

COMMENTERS' CONCERNS

Several comments questioned why the proposed ban would be limited to hog farms while other animal farms can cause pollution concerns, as well. Poultry farming in Northwest Arkansas has long been blamed for excess nutrients in the Illinois River in Oklahoma.

Some comments questioned whether the proposal, as written, would actually prevent hog farms as large as C&H from being constructed in the watershed.

The White River Waterkeeper organization argued that hog farms exceeding the sizes of "medium" or "large" may still be allowed under the language of the proposal, which refers to farms meeting the definition of a concentrated animal-feeding operation.

Further, the comment states, the change to Regulation 5 refers to "confined animal feeding operations," and the change to Regulation 6 refers to "concentrated animal feeding operations." Those are two distinct technical terms meaning different things. The White River Waterkeeper asked whether that would unintentionally allow some farms to obtain permits despite the ban.

More related headlines

Farms are federally classified as small, medium or large. Medium hog farms are defined as having 750 or more swine of more than 55 pounds, or 3,000 or more swine of 55 pounds or less.

Hog farms often have combinations of the two weight classes of pigs. The proposed ban does not explain how to calculate whether a hog farm meets the size threshold if combining the two weight classes of pigs, the White River Waterkeeper contended.

The draft rules could be interpreted as allowing one less hog than the maximum for both weight classes -- 749 bigger hogs and 2,999 smaller hogs, Ross Noland, an attorney and the executive director of the Buffalo River Foundation, wrote in his comment. "This would comprise a major facility with more swine waste present than that which C&H produced."

Medium and large hog farms have been banned since 2014 but only on a temporary basis, pending the conclusion of the Big Creek Research and Extension Team's research on the effect of C&H Hog Farms on Big Creek and the Buffalo National River.

C&H is a large-scale hog farm that sits within the Buffalo National River's watershed. It has been the subject of yearslong environmental concerns and will close in the coming months after reaching a $6.2 million buyout agreement with the state in June.

After signing the buyout agreement with C&H owners, Gov. Asa Hutchinson asked state environmental regulators to petition to make the temporary ban permanent.

The final research report is expected in the coming weeks.

OTHER CHANGES

Not all comments were about the proposed ban on medium and large hog farms.

The proposal places the entirety of two regulations up for amendment. Those are Regulation 5, which governs liquid animal waste management systems that are not allowed to discharge waste, and Regulation 6, which governs federal wastewater permits that allow for discharge.

The department altered numerous provisions within Regulation 6. Some were superficial changes from "Regulation" to "Rule" or "Six" to "6," but some, commenters argued, appeared to change permit application requirements and review processes for facilities that aren't animal farms.

The Beaver Water District opposed several changes, including one that deletes the requirement to disinfect facilities "when necessary" to meet state water-quality standards and another that deletes the requirement to remove nutrients from domestic wastewater effluent "where appropriate." Another change, the group's letter to the department states, would remove many of the permitting requirements for stormwater discharges associated with small construction sites.

The American Fisheries Society and the Buffalo River Watershed Alliance both raised questions about a change allowing higher fecal coliform concentrations in wastewater discharges to extraordinary resource waters and to natural and scenic waterways.

Previously, no concentrations of 200 colonies per 100 milliliters of water were allowed in those waters. The department has proposed changing the limit to a "geometric mean" -- a type of average -- of 200 colonies per 100 milliliters of water, meaning a sample could exceed that concentration as long as the geometric mean remained below 200.

"Whether by averages or geometric means, the application of any mathematical formula should not be allowed to obscure dangerous peak readings when public health is of concern," the Buffalo River Watershed Alliance's comment reads. "Parents allow their children to swim in ERWs on the assumption that this designation means the water is safe for human contact."

The White River Waterkeeper noted that the change is an attempt to be consistent with a separate rule, Regulation 2. But, the organization wrote in its comment, the department has not explained whether the new or the previous language was originally intended. The previous language also listed a limit of an arithmetic mean of 200 colonies per 100 milliliters of water for other water bodies. Geometric means are always lower than arithmetic means, the White River Waterkeeper wrote.

The department issued an executive summary with its proposed changes but didn't mention any reasons for why it altered those specific elements of the regulation. For regulation chapters not accompanied with an explanation, the department's summary states that officials made clarifications, minor corrections and changes to make the regulation consistent with other statutes.

The department did not respond to a request from the *Democrat-Gazette* for comment on the changes.

A Section on 10/14/2019
Print Headline: Hog farm proposal garners support

https://www.arkansasonline.com/news/2019/oct/26/90-days-added-for-hog-ban-comments-2019/

90 days added for hog-farm ban comments

*by **Emily Walkenhorst** | October 26, 2019 at 9:06 a.m.*

FILE — The C&H Hog Farms complex, shown in 2017, was located on Big Creek 6.6 miles from where the creek flows into the Buffalo River. (Mitchell PE Masilun)

People have 88 more days to submit comments on a proposed ban on certain-sized hog farms in the Buffalo National River's watershed.

That's because the final report of the team studying the impact that C&H Hog Farms had on a Buffalo National River tributary has been published.

The Big Creek Research and Extension Team posted the 280-page report, with 619 pages of appendices, online Thursday.

On Friday, the Arkansas Pollution Control and Ecology Commission voted unanimously to reopen the public comment period on the partial hog farm ban for 90 days from Thursday. The comment period lasts through Jan. 21.

"The public needs the opportunity to look at it," Commissioner Mike Freeze said of the report.

Freeze and other commissioners said in July that they wanted to withhold allowing the partial ban to begin going through the rule-making process until the report was completed. At the time, they believed the report would be released imminently. They voted in favor of initiating the rule-making with the understanding that the public comment period could be altered to accommodate the report's release.

The original comment period closed in September and amassed more than 400 comments. All but two favored the ban.

Experts reached Friday said they hadn't had much time to scan the report.

Gordon Watkins, president of the Buffalo River Watershed Alliance, said he wanted to read it before commenting. He said he had read several pages but not much.

David Peterson, president of the Ozark Society, said the report showed the gravity of phosphorus buildup in soil over time, suggesting adjustments to how C&H was applying its phosphorus-rich manure mixture, called "slurry," to the ground.

That backs up his group's and other groups' concerns about how farms are advised and required to apply fertilizers to the ground.

"It actually substantiated some things that we thought were true and had analyzed in the data before," Peterson said.

As of late Friday, Peterson said he had read fewer than 40 pages, although that was more than many others.

John Bailey, director of environmental and regulatory affairs for the Arkansas Farm Bureau, said he began reading the report Friday. He'd read the executive summary and conclusions before telling the *Arkansas Democrat-Gazette* that it appeared to support what the Farm Bureau has said -- that C&H wasn't worsening Big Creek.

"What I feel like this document says is what we've been trying to say all along, is that there's no environmental impact," he said.

More related headlines

But, Bailey added, the report makes some observations that the Farm Bureau could take to heart, namely suggestions for how to better apply manure to land to minimize environmental impact.

"What we're going to have to focus on is, is there a better way to manage this, to keep phosphorus on site," he said.

Big Creek flows into the Buffalo River more than 6 miles from where C&H abuts it. C&H is permitted to house up to 6,503 hogs, although it normally operated with only about 3,000. It will close by the beginning of next year under a $6.2 million buyout from the state, brokered by Gov. Asa Hutchinson.

Hutchinson focused on the Buffalo in his weekly address Friday. He acknowledged a wide variety of potential threats to the river but vowed to work toward protecting it.

"We want to preserve this treasured resource," he said.

The Big Creek Research and Extension Team, comprised of 10 researchers and several field technicians, did not find that C&H had been contributing to algal blooms or other water quality issues along the Buffalo or Big Creek.

Researchers found that certain concentrations of nutrients did not appear to have increased since the beginning of the study through the end.

The final sentence of the report reads, "as long as the integrity of the holding ponds is maintained, the main long-term environmental concerns with CAFO [concentrated animal feeding operation] lies with land use and nutrient management of the fields permitted to receive slurry."

On a few occasions, researchers noted that a lack of data on conditions prior to C&H's operations prevented them from drawing conclusions.

FARM OPENED BEFORE STUDY

The study did not begin until several months after the farm began operations. That means researchers could not compare their measurements of nutrient concentrations during C&H's normal operations to what they were before C&H opened.

Grazing, slurry and fertilizer managements on three fields may have increased the potential loss of phosphorus and nitrogen into Big Creek, researchers wrote. But the report said researchers did not have background data, including historical nutrient management and nutrient application to the land.

The team sampled water from September 2013 until July. That monitoring focused on five things, according to the report: the impact of slurry on soil fertility; nutrient runoff; trends in the water quality of three different spots on the farm; nutrient loads in Big Creek; and trends in nutrient and bacteria concentrations up and downstream of C&H.

Any additional nutrients applied to C&H's fields should limit the slurry specifically for its phosphorus concentrations, researchers determined. Continued application at the rate it was applied from 2014 to 2018 would result in enough phosphorus in the soil to run off into nearby waters.

The facility had statistically significant increases in nitrate concentrations in a stream and water well on facility property, researchers concluded. Tests of other substances suggest that the concentrations are not attributable to holding pond manure.

Two storms in May and December 2015 put large amounts of nutrients in Big Creek. Those storms contributed the majority of the five-year overall nutrient loading into the creek. As a result, researchers recommend that conservation measures to minimize nutrients runoff be focused on the manure and method of application, versus managing the transport of the manure.

Researchers found phosphorus and nitrogen concentrations in Big Creek to be higher downstream of C&H than from upstream, but not at statistically significant amounts when adjusting for stream flow variability.

"Concentrations in Big Creek were similar to other watersheds in this region with similar land use, suggesting limited impact of the CAFO on Big Creek at the present time," the report reads. "However, this does not preclude future impacts of agricultural and urban operations in the watershed."

PARTIAL BAN

The partial ban is for federally classified medium and large hog farms in the Buffalo National River's watershed. That's a slightly smaller watershed than the whole Buffalo River, which is 15 miles longer than the National River designation.

Farms are federally classified as small, medium or large. Medium hog farms are defined as having 750 or more swine of more than 55 pounds, or 3,000 or more swine of 55 pounds or less.

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Metro on 10/26/2019

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Arkansas commission begins process of hog farm ban on Buffalo National River

Posted: Sat 7:44 PM, Jul 27, 2019

LITTLE ROCK, Ark. (AP) — The Arkansas Pollution Control and Ecology Commission has approved the start of a rule-making process to permanently ban medium and large hog farms from the Buffalo National River watershed.

The Arkansas Democrat-Gazette reports that the proposal will go out for public comment and a public hearing, then state legislative committees must review the plan before rule-making can proceed.

Gov. Asa Hutchinson supported the permanent ban after signing an agreement in June for a $6.2 million state buyout of C&H Hog Farms, the only large hog farm in the river's watershed.

C&H is located on Big Creek, about 6 miles from where it joins the Buffalo River and is permitted to house about 6,500 hogs. The farm has been opposed since it opened in 2013 by environmentalists concerned about pollution.

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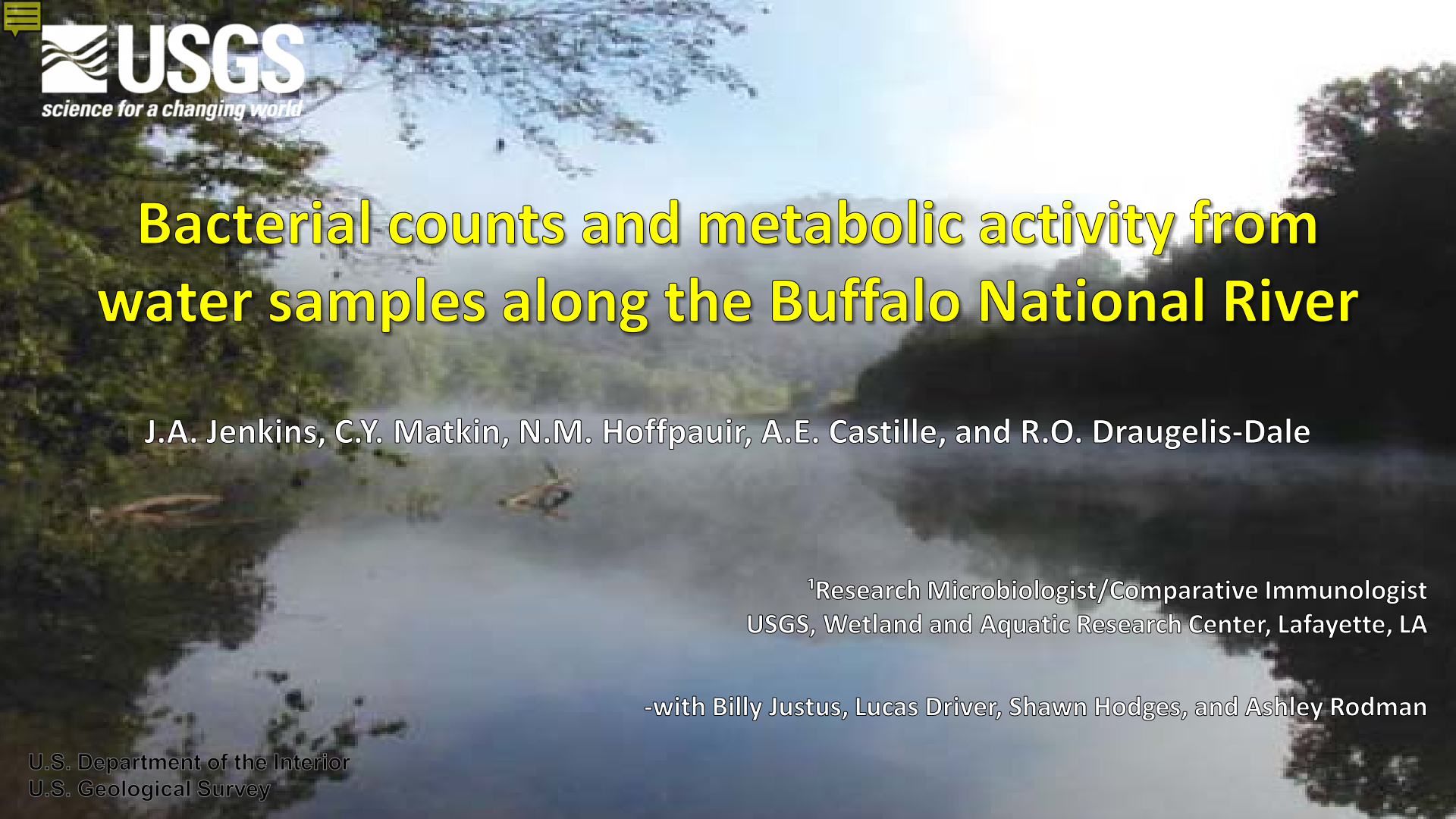
Information from: Arkansas Democrat-Gazette, http://www.arkansasonline.com



USGS
science for a changing world

Bacterial counts and metabolic activity from water samples along the Buffalo National River

J.A. Jenkins, C.Y. Matkin, N.M. Hoffpauir, A.E. Castille, and R.O. Draugelis-Dale

[1]Research Microbiologist/Comparative Immunologist
USGS, Wetland and Aquatic Research Center, Lafayette, LA

-with Billy Justus, Lucas Driver, Shawn Hodges, and Ashley Rodman

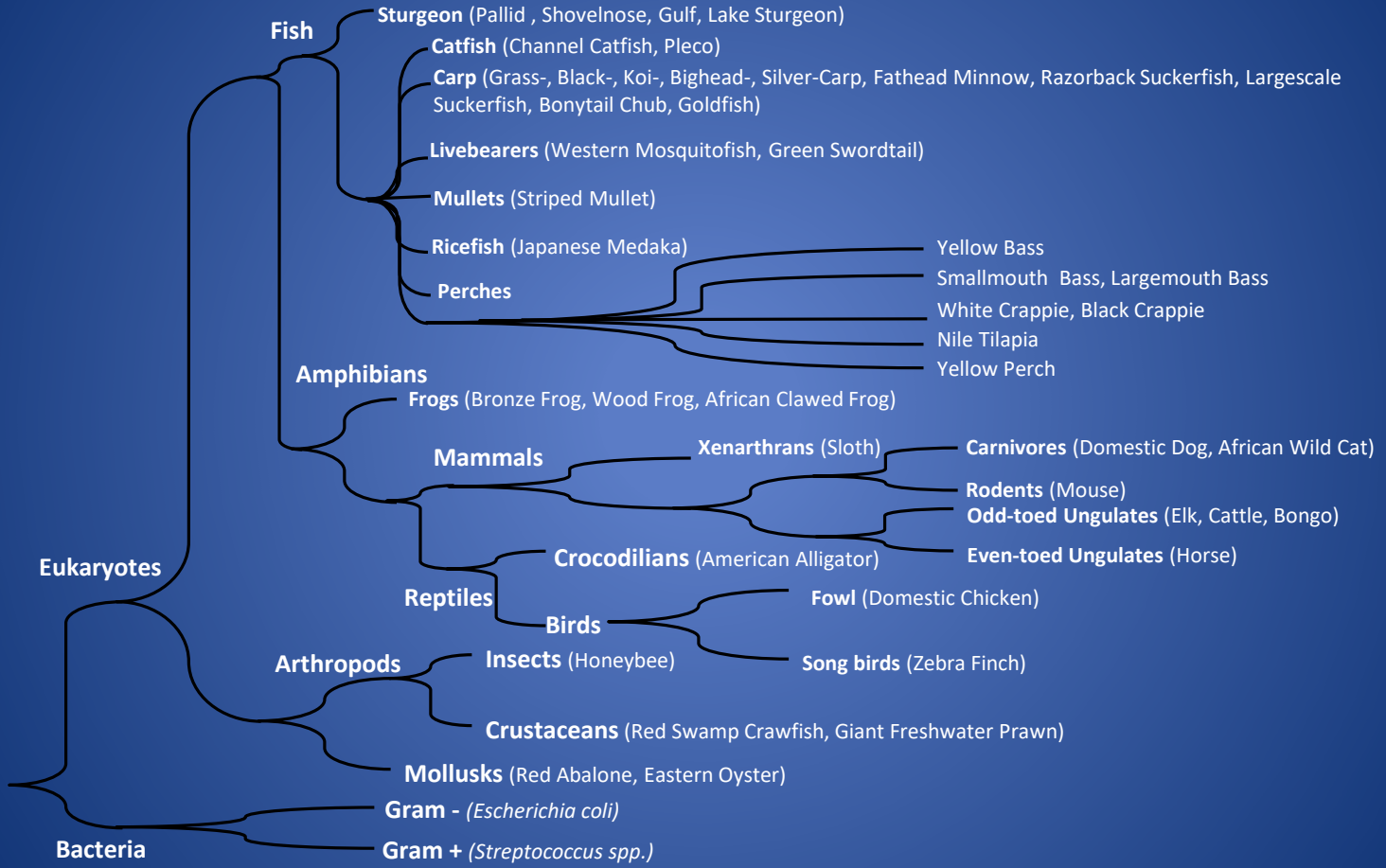
U.S. Department of the Interior
U.S. Geological Survey

Today's Objectives

- Present hypothesis and results
- Show how hypotheses are tested
- Introduce lab capabilities
- Consider ideas

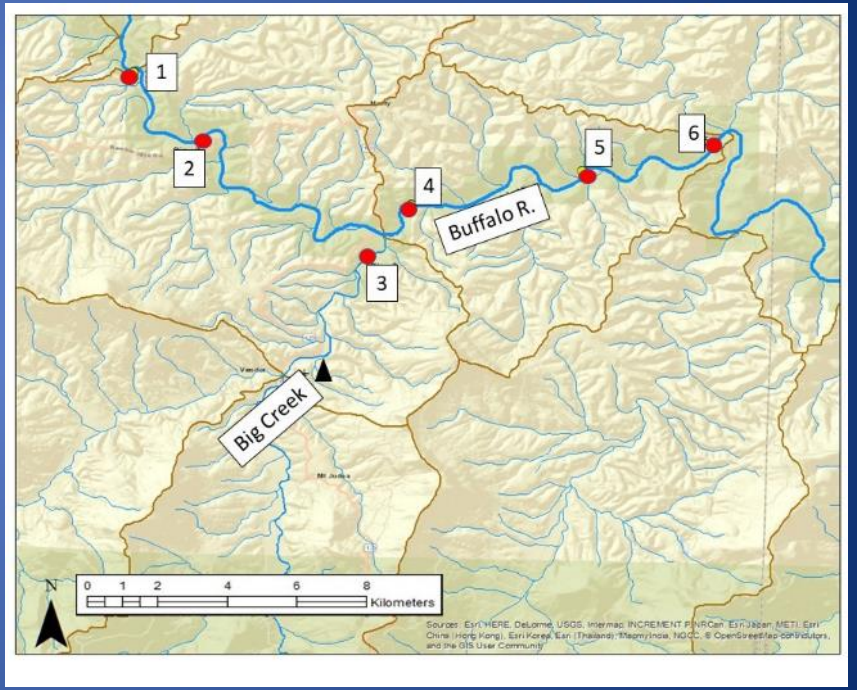
USGS

Phylogenetic tree displaying species studied by flow cytometry in this laboratory



USGS

Hypothesis: Potential differences in water quality along the Buffalo National River: determined via overall bacterial counts and metabolic activity

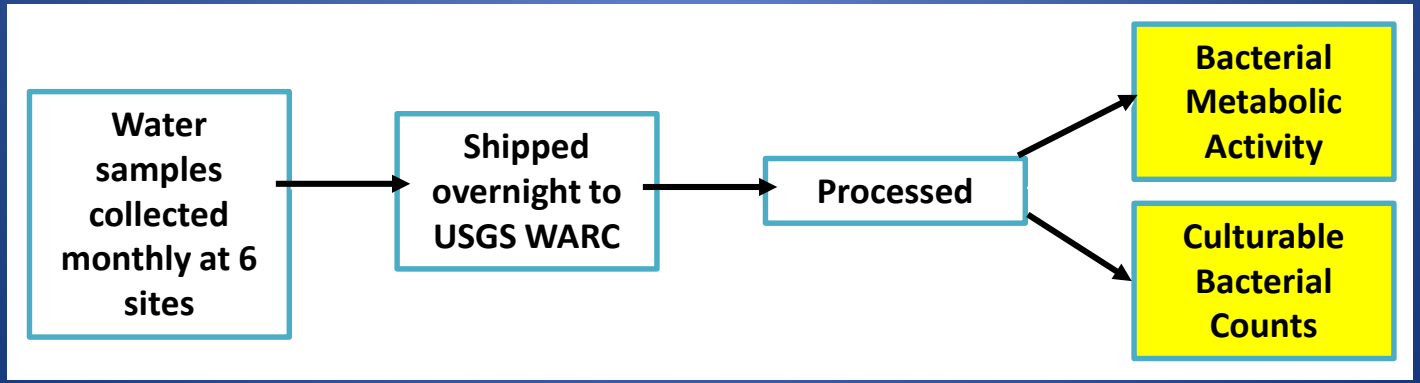


Red dots are the water sampling sites.

USGS

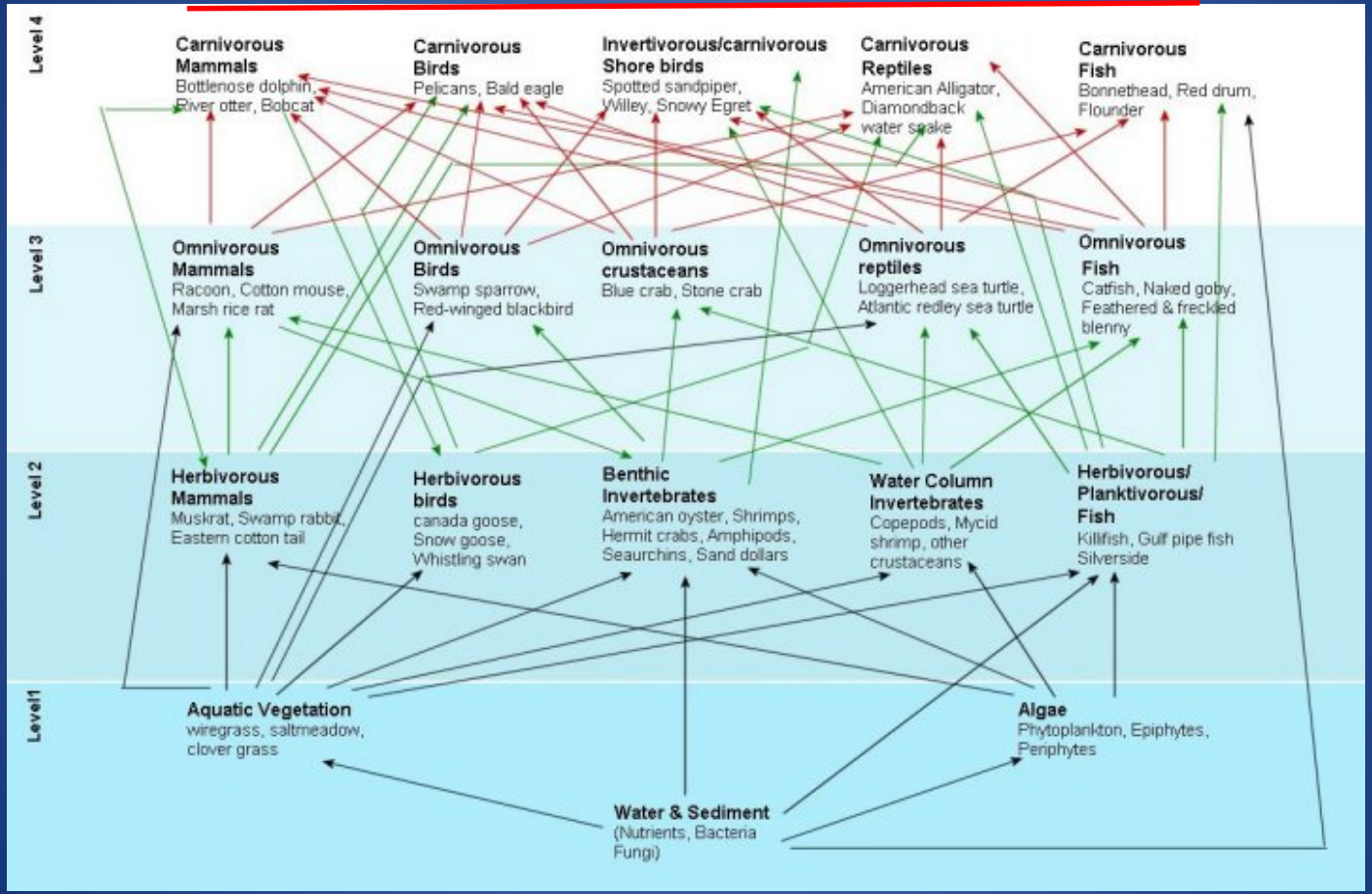
Proposal Concepts-Experimental Design

- Basic water quality parameters: turbidity, DO, pH, temp., conductivity etc. (USGS database - NWIS)
- Nutrient compounds: N species (NH_4, NO_2, NO_3), P species (Ortho P, etc.)
- Hydrology: use of gages and hydrographs, flow regime, mass balance of water, precipitation
- Periphyton, Chl A quarterly
- Total coliforms and *Escherichia coli,* fecal indicators with IDEXX system
- Heterotrophic bacteria



USGS

Aquatic Food Web



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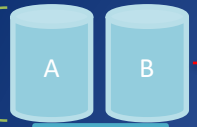
Laboratory Processing

250mL per bottle

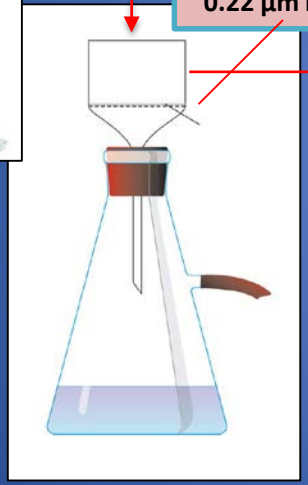


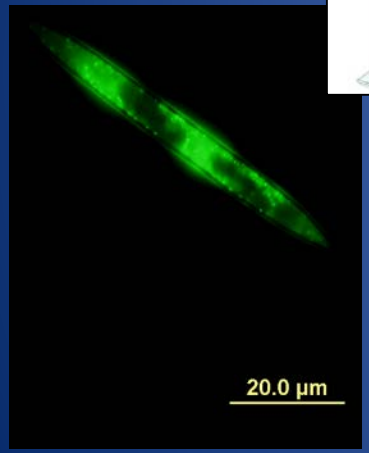
Per Site

Water resuspended and allowed to reach 24°C

1st Filtration
7 µm nylon mesh to remove algae

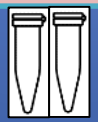
2nd Filtration
0.22 µm membrane



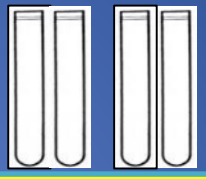


Concentrated Bacterial Filtrate

Cell Preservation



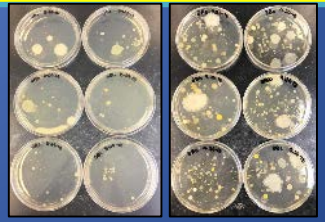
To be used for total bacterial count



Bacterial Metabolic Activity

Fluorescence Staining Assay for Flow Cytometry
- 5(6)-Carboxyfluorescein Diacetate (CFDA)
- Propidium Iodide (PI)

Live, Culturable Bacteria, Plate Counts



USGS

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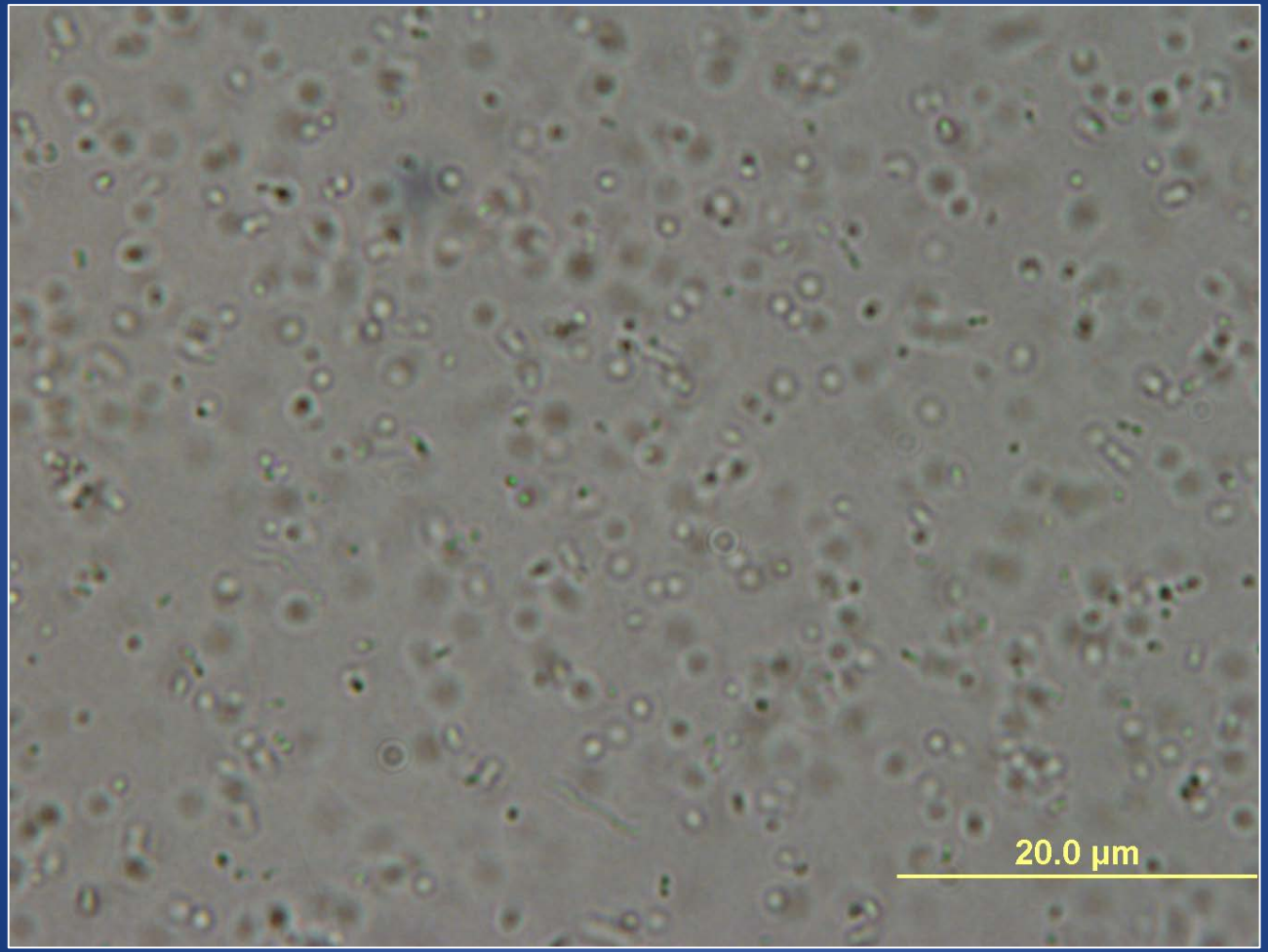
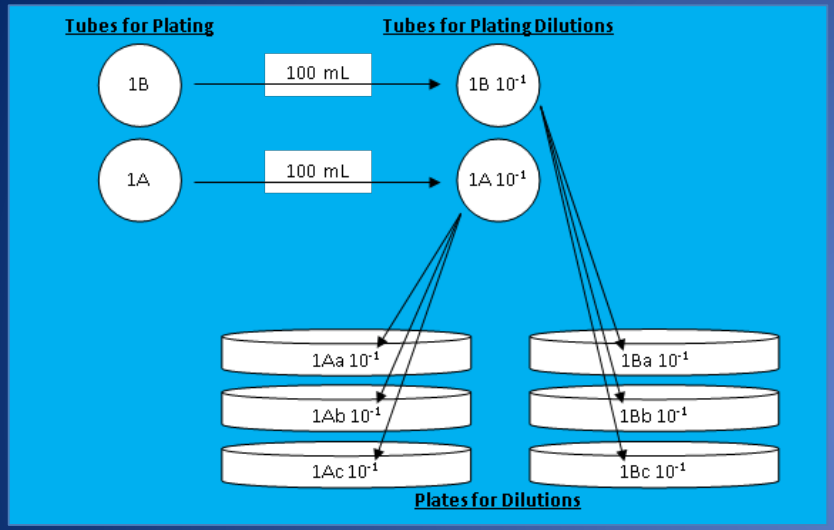
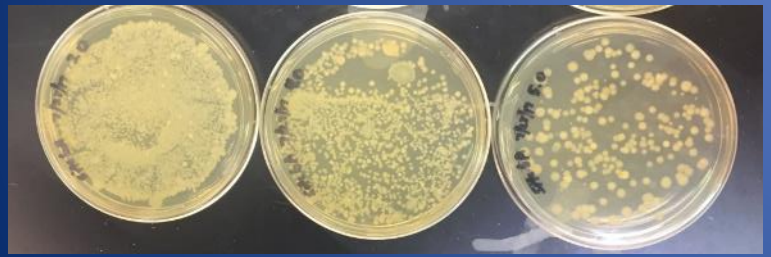
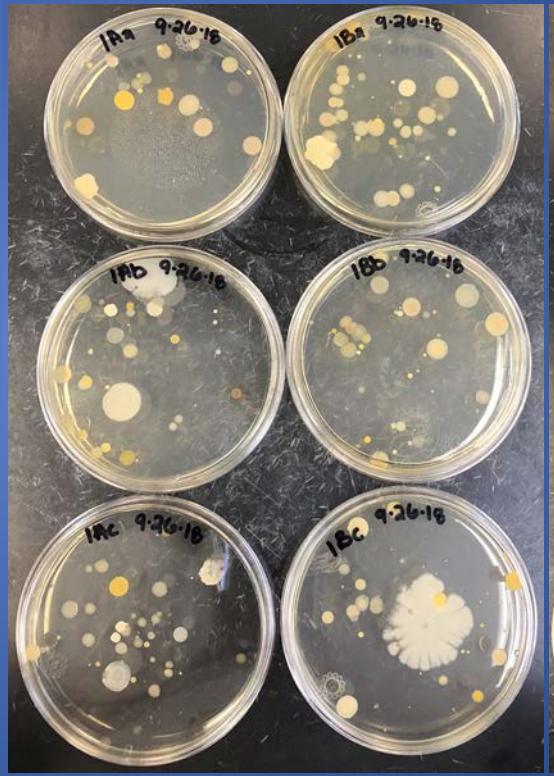

20.0 µm

September 2018

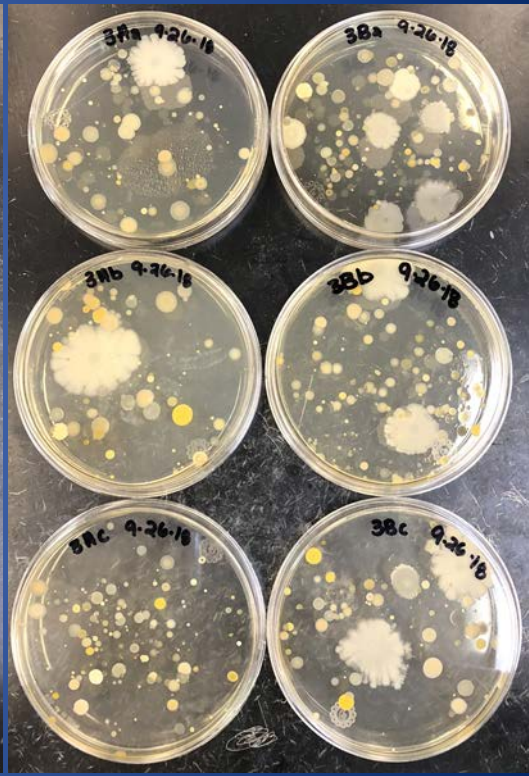




Site 1



Site 3



USGS

On the Results of Cultural bacterial colonies per site analyzed by ANOVA:

Heterotrophic plate count (HPC) measures a range of Gram positive and Gram negative bacteria that are naturally present in the environment.

March 2018 – flooding event in AR made sampling unsafe so no samples were received.

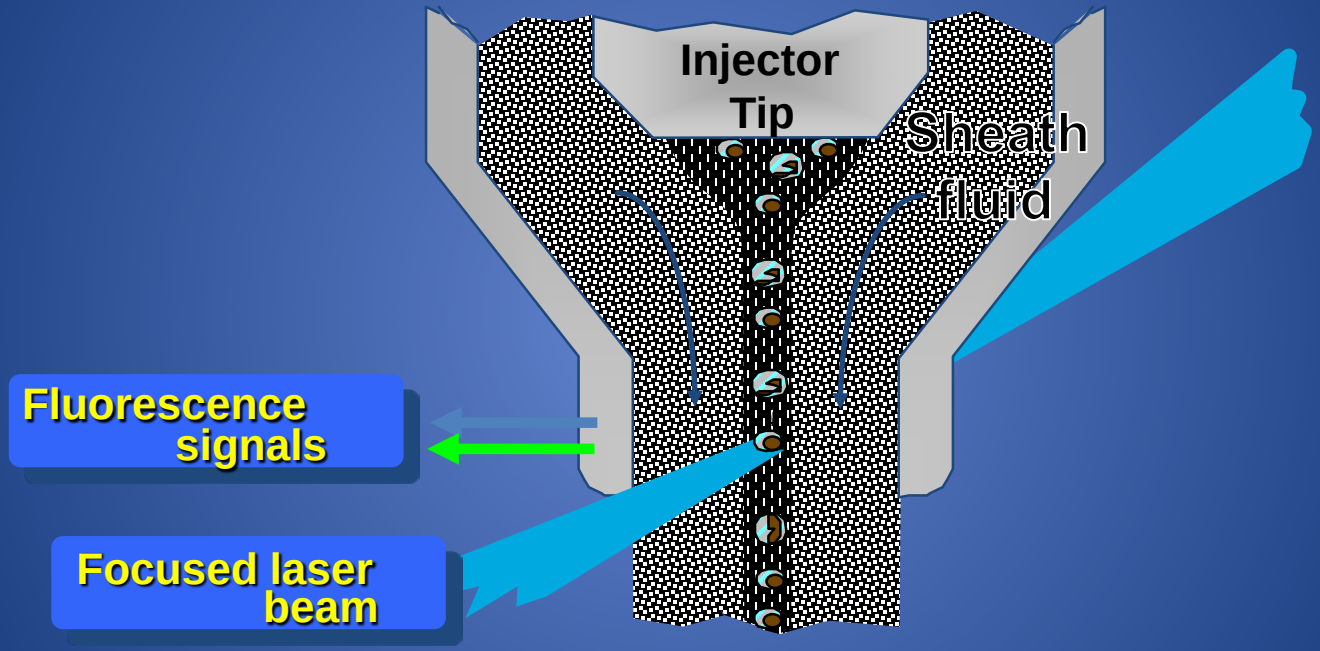
October 2018 – unable to process samples for sites 4, 5, and 6 due to delayed receipt of shipment. 48 hours too late for processing.

11 out of 15 months showed significant differences in bacterial counts among sites sampled (73%)

Site 3 showed the highest bacterial counts for 5 of those 11 months (45%)

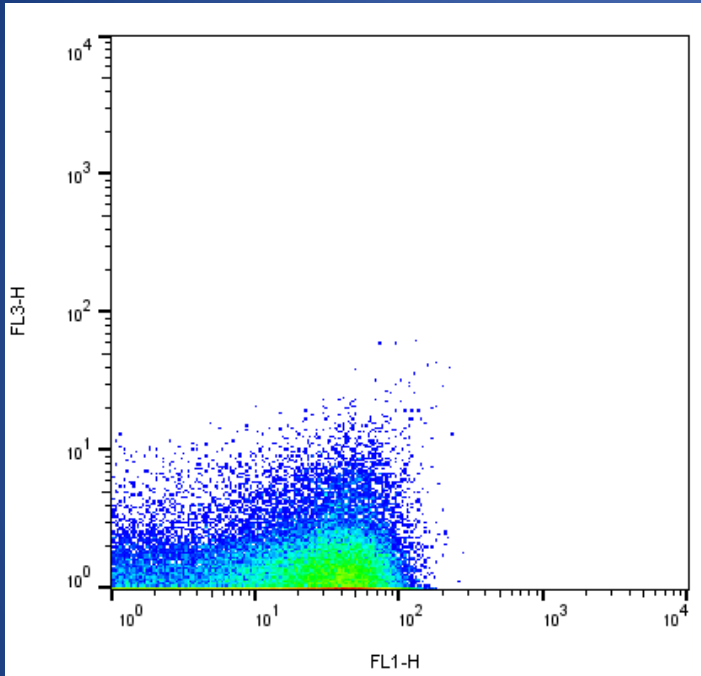
USGS

Flow Cytometry

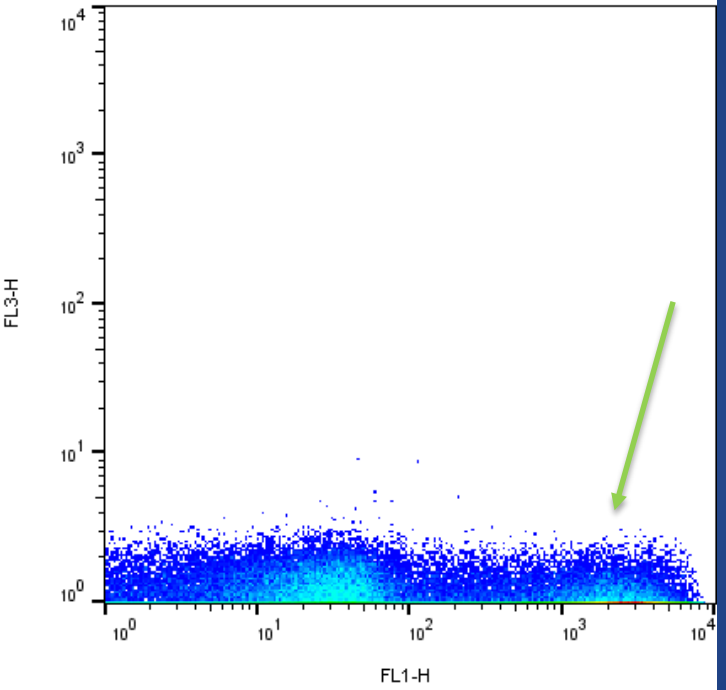


USGS USGS

Staining Controls Using 5(6)-Carboxyfluorescein Diacetate (CFDA)



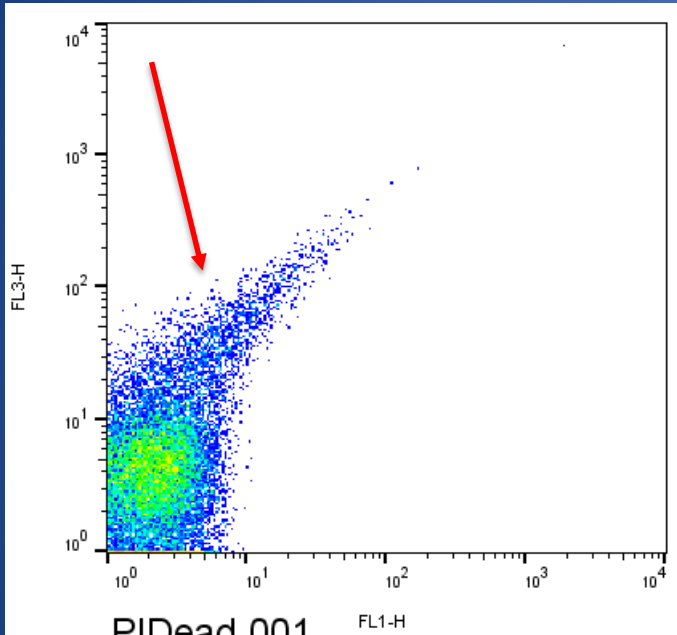
CFDADead.001
Ungated
47081



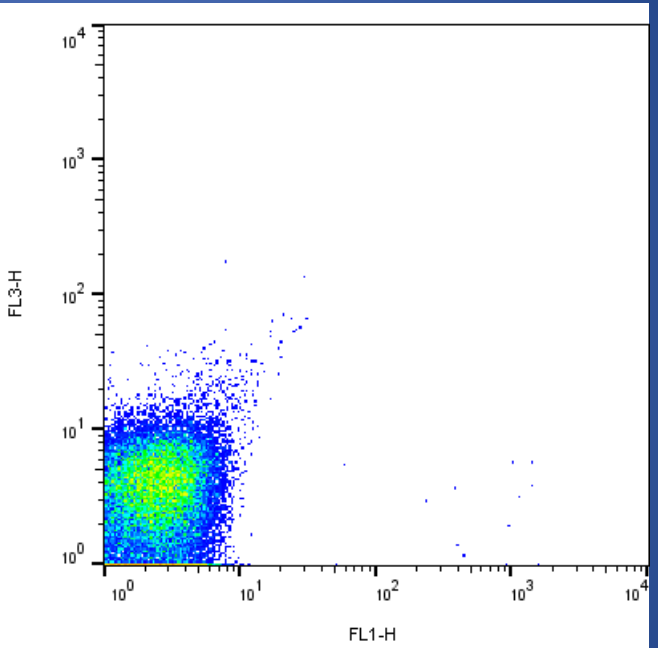
CFDALive.001
Ungated
94291

USGS

Staining Controls Using Propidium Iodide (PI)



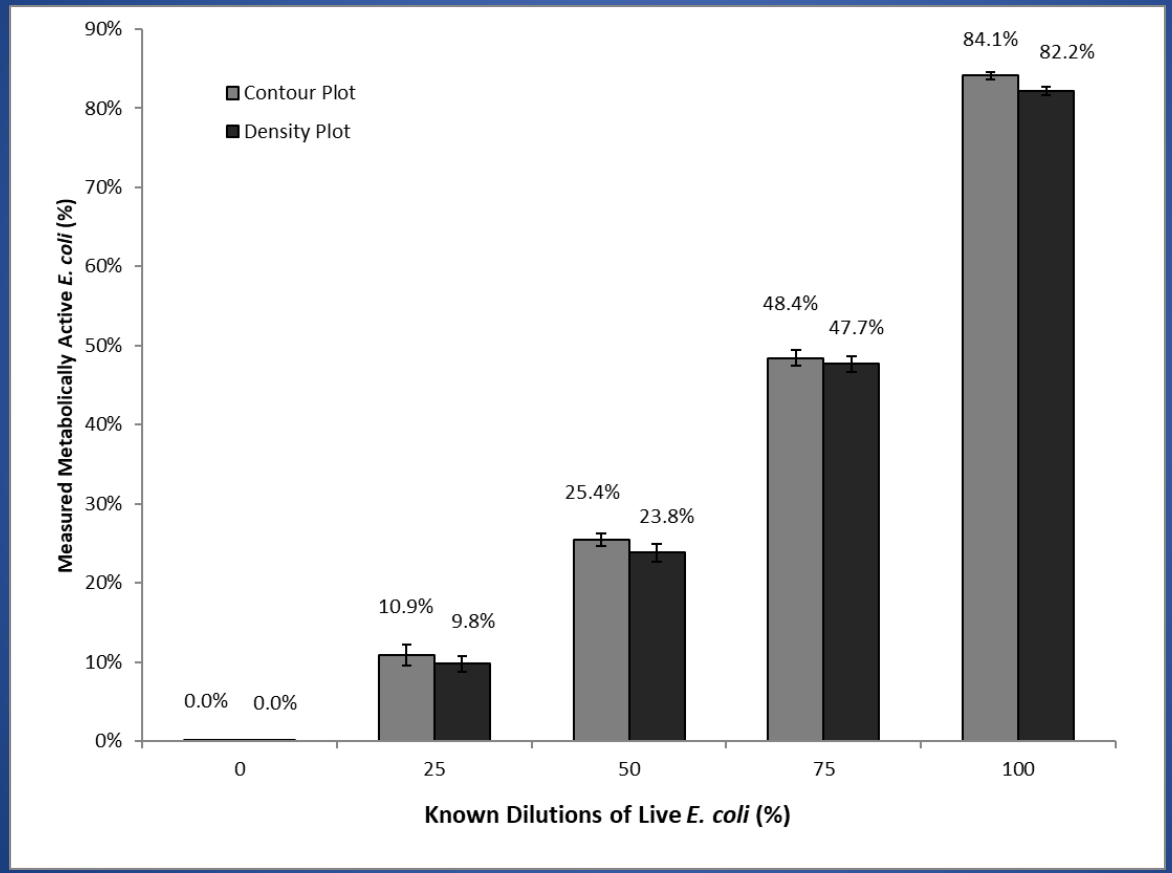
PIDead.001
Ungated
22078



PILive.001
Ungated
32138

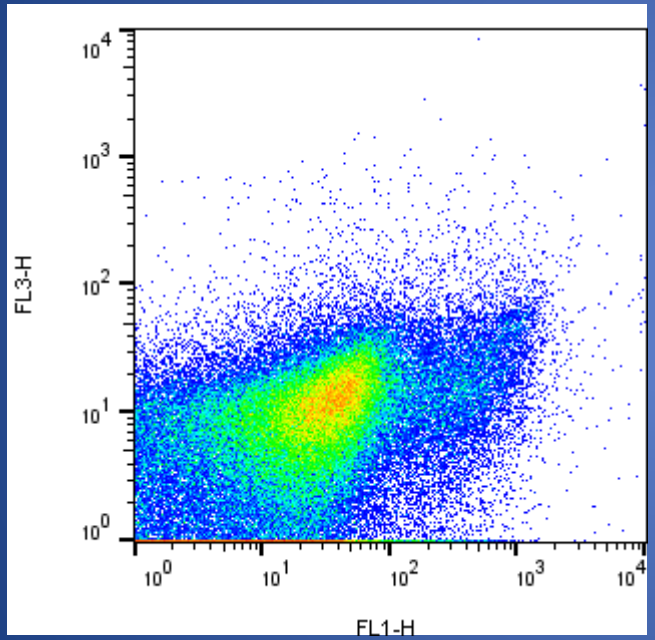
USGS

Method Validated: *E. coli* esterase analyzed by two flow cytometric software

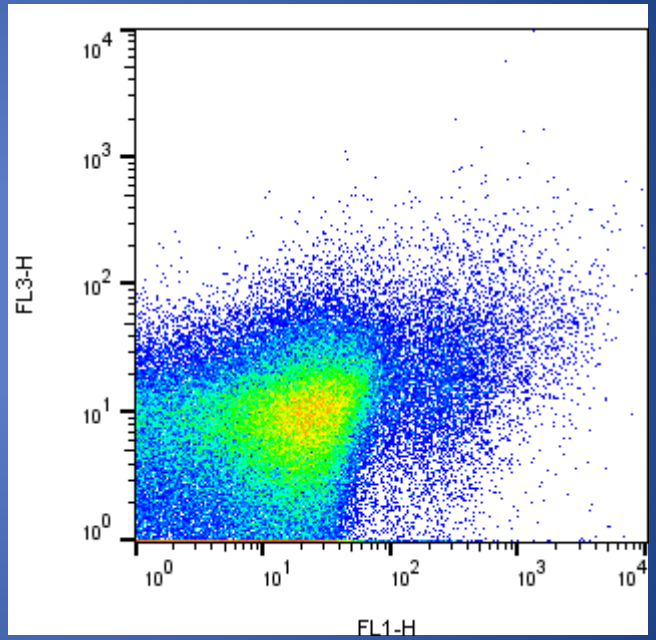


USGS

Typical Cytograms, Month 6, Oct 2017



Site 1

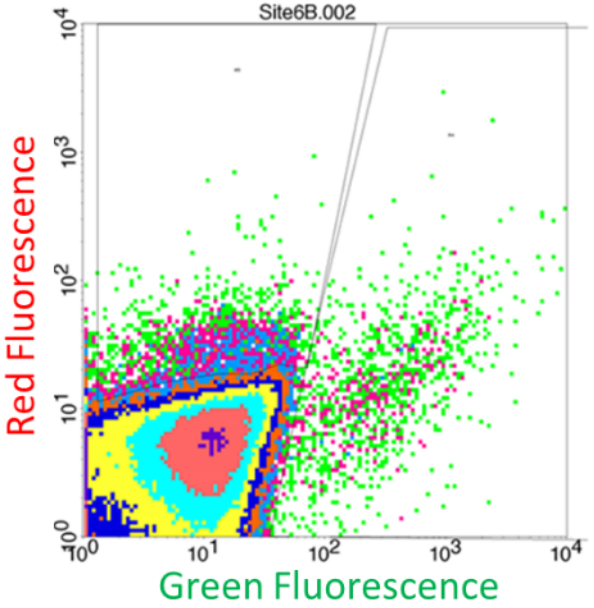


Site 3

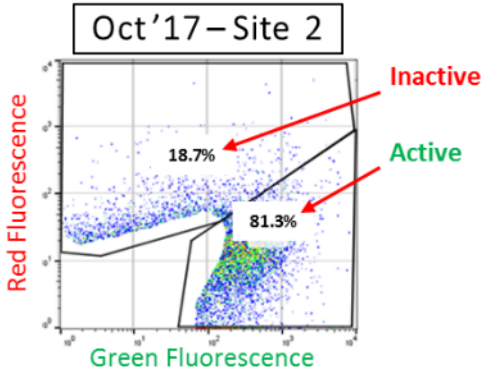
USGS

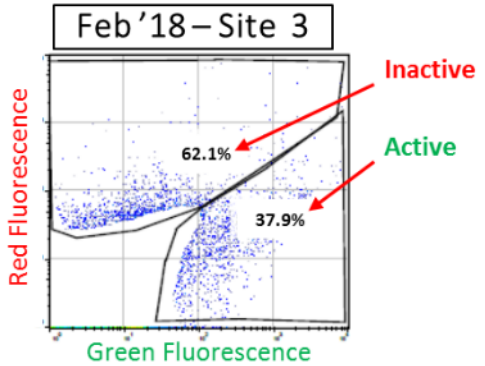
Sample Flow Cytograms

Ungated



Gated





USGS

Bacterial metabolic activity (n = 4) by site analyzed by ANOVA

We investigated if there was a statistical difference in metabolic activity among sites for 17 months.

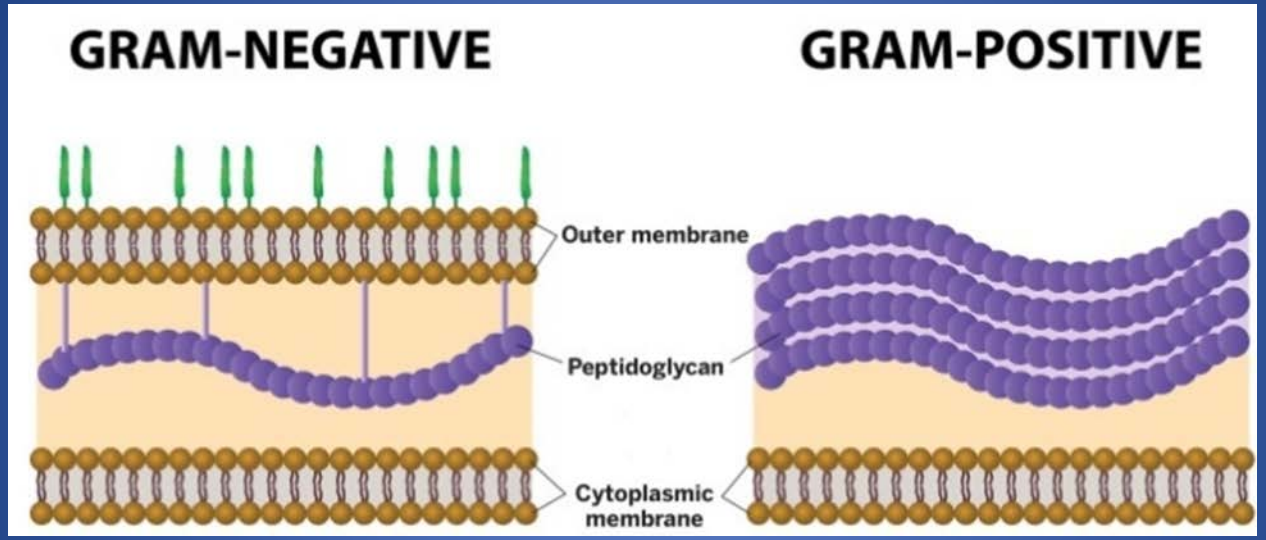
16 out of 17 months showed significant differences in metabolic activity among sites sampled (94%)

Site 3 showed the lowest metabolic activity for 12 of those 17 months (71%)

There were 4 months out of the 15 months analyzed that showed site 3 as having the lowest metabolic activity as well as the highest bacterial counts. Perhaps the total cell counts will yield insight into this result.

USGS

Bacterial Cell Wall Types



USGS

Environmental Fungi

USGS

DNA sequencing: Environmental Metagenomics: Univ. of NH – Dr. B. Brown

21 BNR water samples: PCR amplified 16S ribosomal subunit V4.

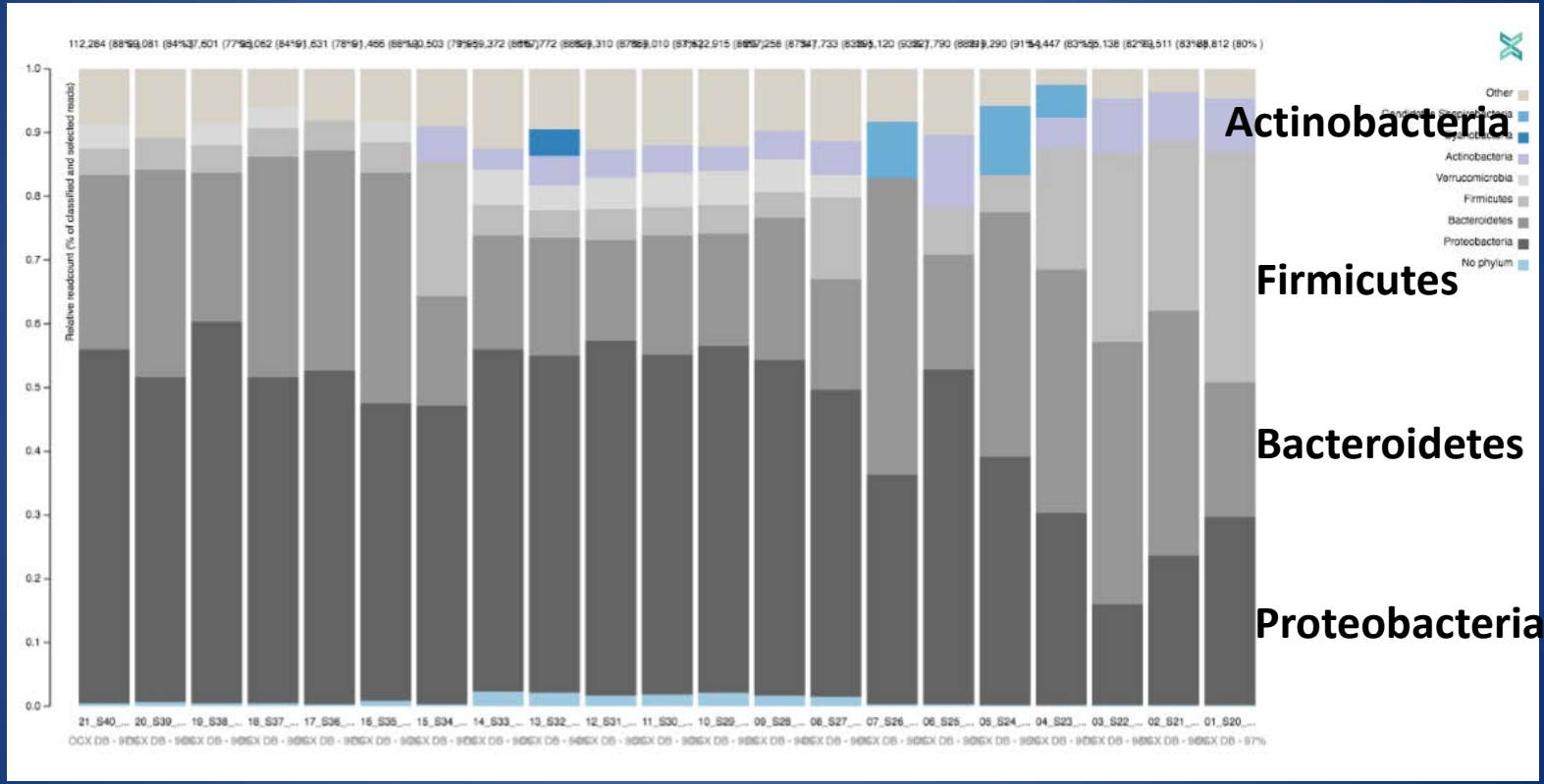
Looks at large database of sequences from known microbes, sees the taxonomic composition of that water sample.

The relative proportions gives a rough estimate of the abundance of the taxa identified in a sample.

The data also can be used to predict functions of the microbial consortia.

USGS

NPS Buffalo National River - Phylum



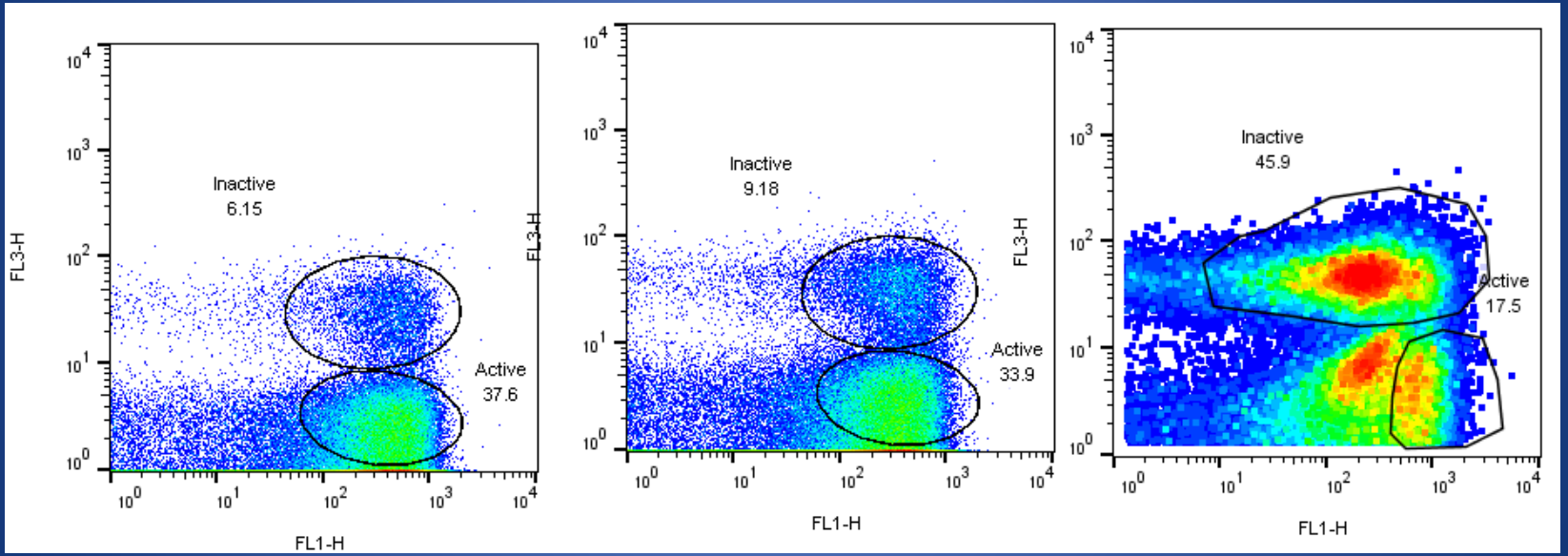
Pharmaceutically Active Compounds

17 α ethinylestradiol (EE2):	25, 5, 1 ng/L
Trenbalone	80, 40, 10 ng/L
Atrazine	10, 3, 1 ug/L
Penicillin	1500, 750, 375 ug/L
Pen/Streptomycin	100 units-100 ug/mL; 50-50; 25-25
Tylosin	1000, 500, 100 ug/L
Tetracycline	1500, 750, 375 ug/L

Hypothesis: Is metabolic activity influenced by simulated confined animal feeding operation (CAFO) mixtures?

USGS

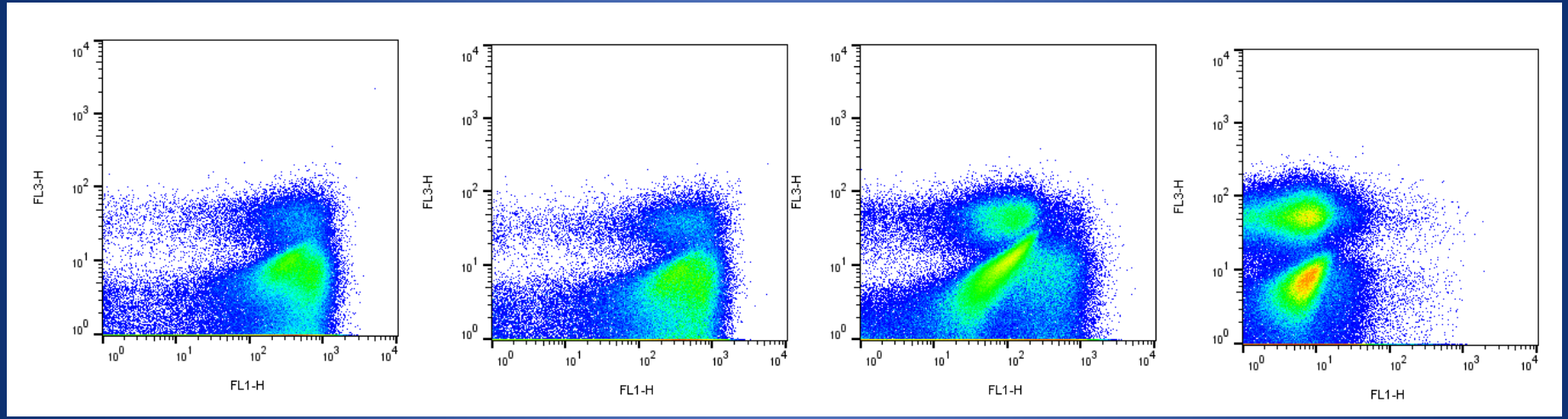
Penicillin



Control Low High

USGS

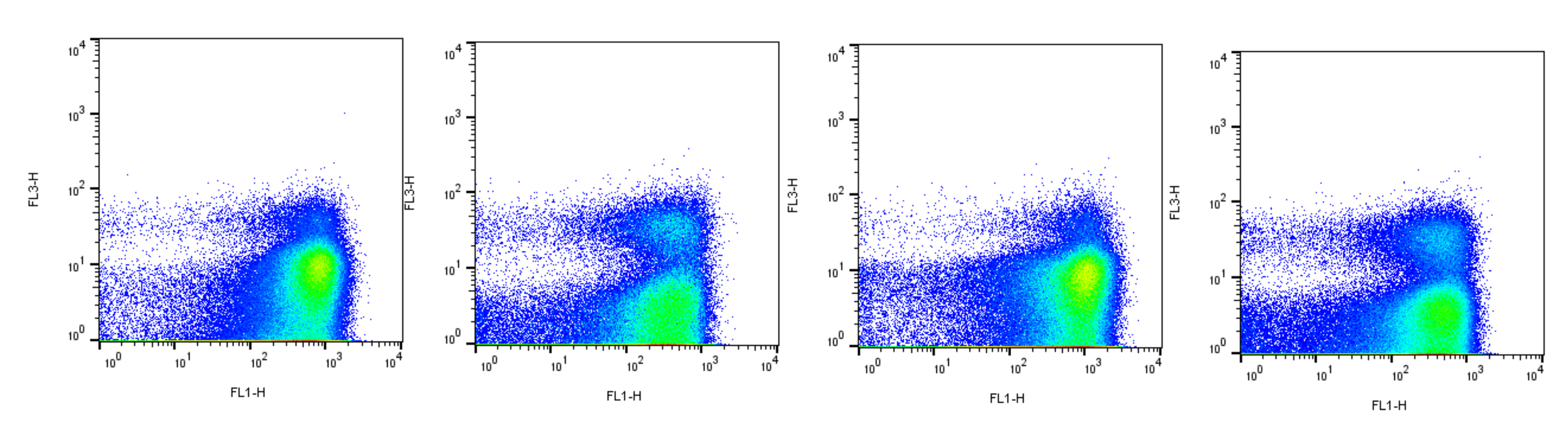
Atrazine



Control Low Med High

USGS

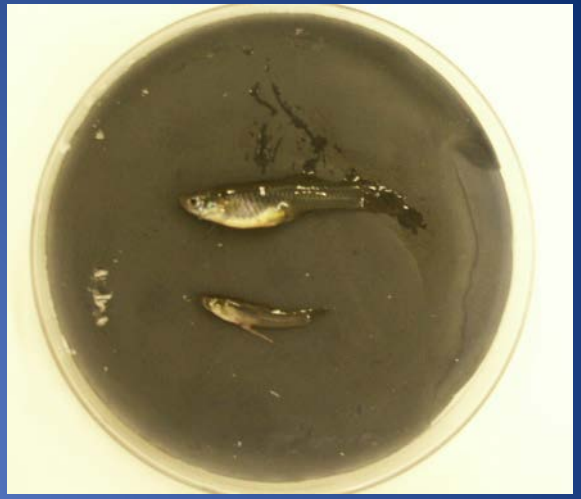
Trenbolone

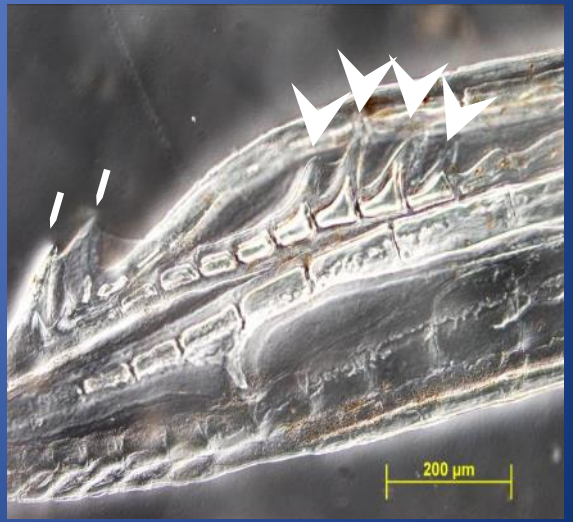


Control | Low | Med | High

USGS

Western Mosquitofish, *Gambusia affinis*
Biomarker study w/ simulated CAFO runoff



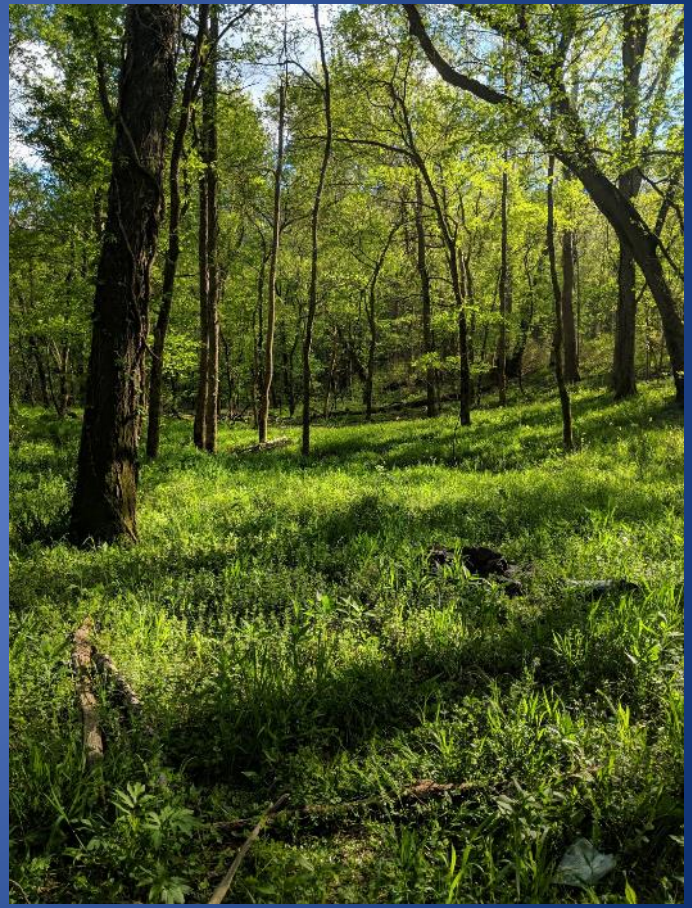


Results

- Although higher bacterial metabolic activity was hypothesized to occur at Big Creek due to likely introduction of organic nutrients into BNR from a swine farm, Big Creek showed the lowest metabolic activity for 71% of the months analyzed.

- Overall bacterial metabolic activity at all sites was lower in the colder, winter months.

- Highest live bacterial counts were associated with local rain events.



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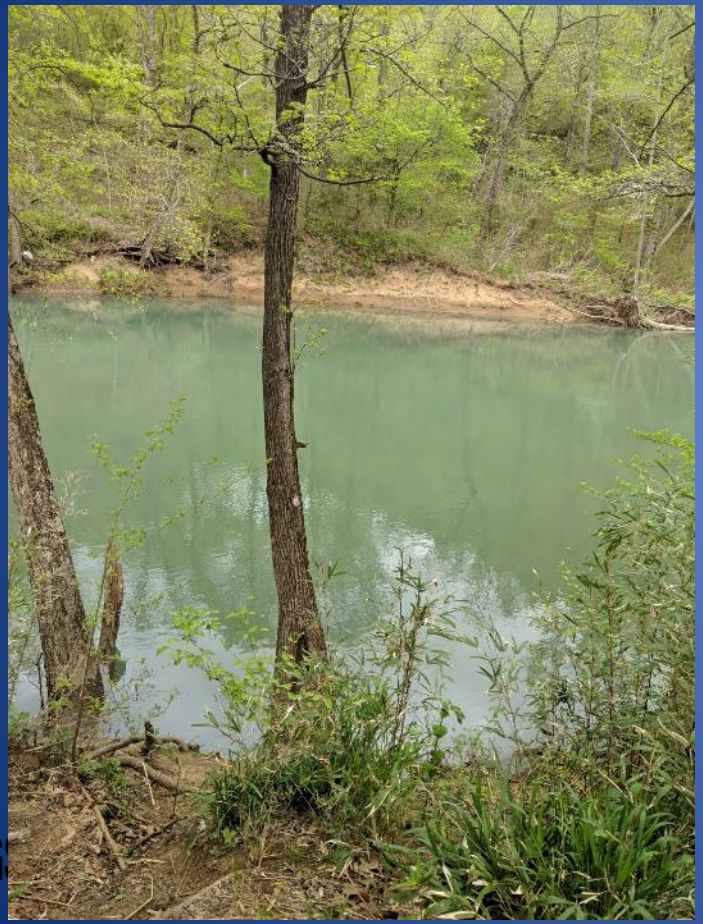
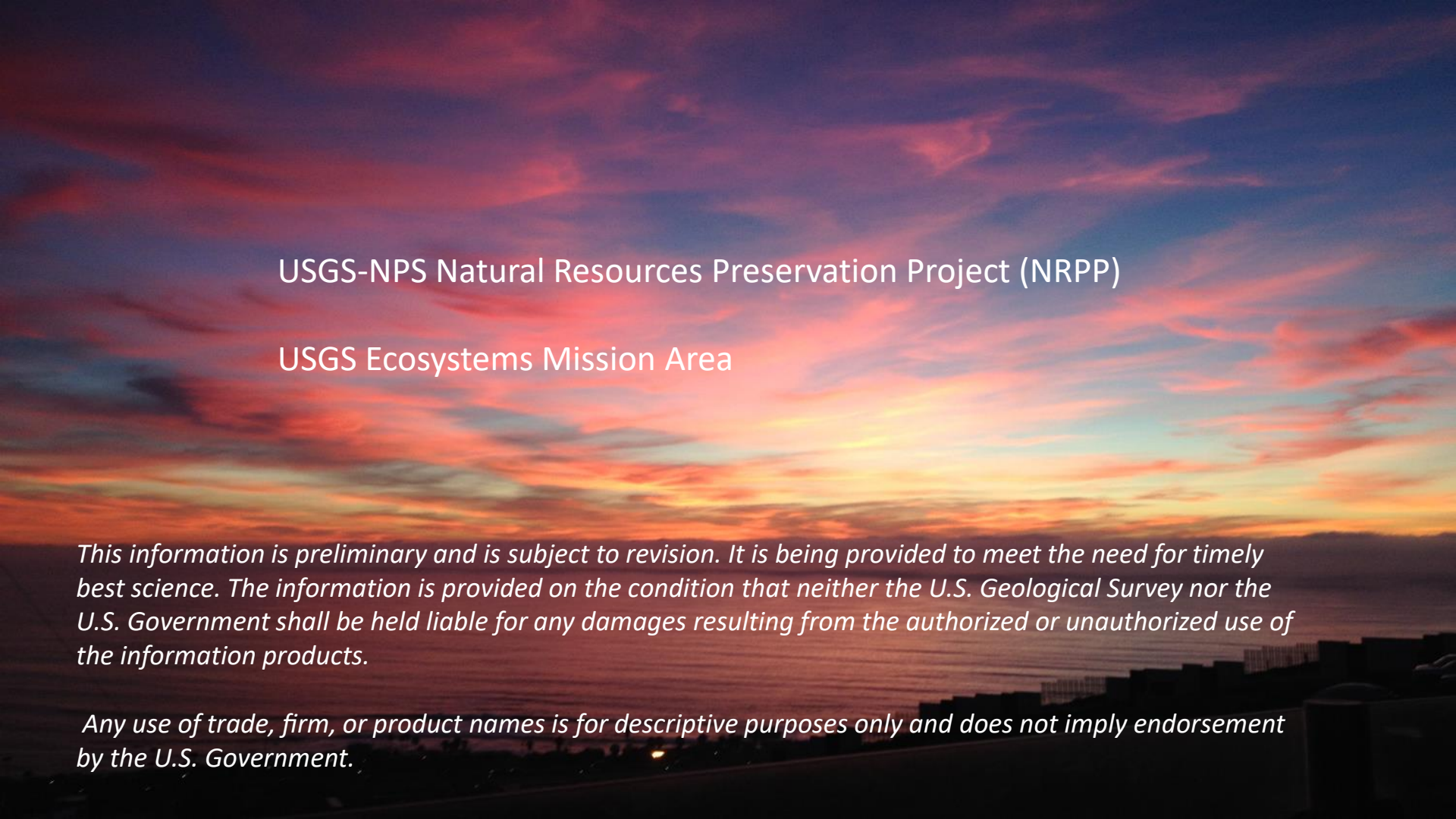
Conclusions



- The results presented in this study are part of a 19-month project and will be combined with other environmental water-quality data and fecal bacterial indicators.
- Nutrients/organics and bacteria may originate from other distant sources in the Big Creek watershed.
- Results point to broader implications for river ecosystem services.



USGS-NPS Natural Resources Preservation Project (NRPP)

USGS Ecosystems Mission Area